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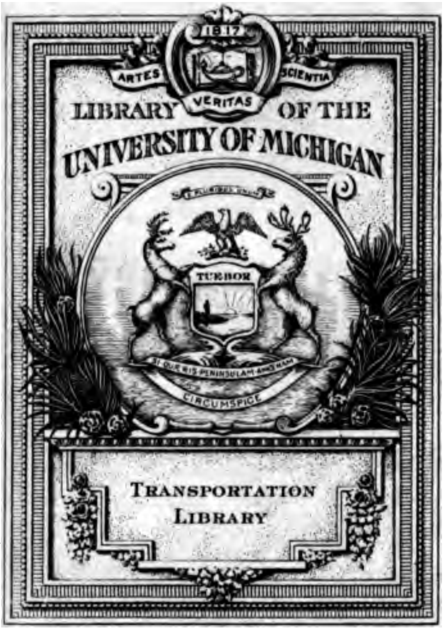

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OBSERVATIONS
ON THE
FORMATION, STATE AND CONDITION
OF
TURNPIKE ROADS AND OTHER HIGHWAYS
WITH
SUGGESTIONS FOR THEIR PERMANENT IMPROVEMENT
ON
SCIENTIFIC PRINCIPLES
BY MEANS OF THE
NATURAL MATERIALS
OF WHICH THEY ARE COMPOSED:
To which is added,
A PRACTICAL SYSTEM
(On the like Principles)
FOR THE CONSTRUCTION
OF
SOUND SUBSTANTIAL ROADS
AND
UNDER-DRAINS
BY MEANS OF A
PATENT SUBSTITUTE
FOR HARD ROAD MATERIALS,
WHERE
Such Substances are not Practically Obtainable.

BY A. H. CHAMBERS, Esq.

London:
PRINTED FOR THE AUTHOR,
And may be had at 21, Upper George Street, Bryanstone Square; Atwell's Library, 2, Brown Street, Bryanstone Square; Gardiner and Son, Princes Street, Cavendish Square; Harding, St. James's Street; Williams, Strand; Rodwell, Bond Street; Hatchard, Piccadilly; Bell, Oxford Street; Richardson, Cornhill; and of all other Booksellers.

1820.

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IN procuring ashes from clay by incineration for Agricultural purposes, many large lumps were found to be so completely calcined, and others partially fused in the process of burning, as to render them incapable of absorbing water, and consequently they remained on the ground unaffected by the severest frosts of last winter. This circumstance combined with the general encomiums of travellers on roads formed of lava in the neighbourhood of Volcanoes, encouraged a hope, that VITRIFIED CLAY might be made available as a substitute for hard Road materials, in those districts, where such substances are not procurable, but at an expense which forbids their application to the making and repairing of Roads. Encouraged by this idea, His Majesty's Letters Patent were solicited and obtained for these and other useful purposes (among which is the Under-draining of Land) in March last; since which time an experiment in the formation of a Road with a substantial impervious foundation—and the immediate and continued discharge of water from Under drains, both of which works were entirely conducted on Scientific principles, and constructed with Patent materials; afford a well grounded confidence that this systematical process, will be found highly beneficial and desirable, where fit and proper materials for Road-making and Under-draining, cannot be practically obtainable.

THE PATENTEE.

No 21, Upper George Street, Bryanstone Square.
1st June, 1820.

OBSERVATIONS,

&c. &c.

IT cannot be regarded but as an unaccountable circumstance, that the arts of domestic use, in which all are interested, should be found to proceed so slowly towards improvement, while those of a decorative, or purely ornamental nature, in which few can indulge, are daily making strides towards perfection.

Notwithstanding the beneficial assistance which chemistry has recently afforded to many branches of our manufactures—yet are there still many others in which its aid is either injudiciously rejected, from an apprehension of expense, or its introduction considered an unnecessary round-a-bout way of producing the desired effect. The extremely nice, nay delicate processes of making butter and cheese, may be adduced as instances; these operations are conducted with little variation, for aught known to the contrary, in the same unscientific manner with which they were probably pursued at the commencement of the christian era;—after which 1780 years had expired, before the thermometer was found to be essentially useful in the brewing of malt-liquors; previously to which time, the conductors of Breweries were deemed to be the most skilful, who, like the Dairy maids of the present day, had the best guess.

The application of science generally in the several departments of the manufacture of wheel-carriages—though exclusively of a pleasurable description, may be offered as another instance of the little attention paid to the rules of science, even where such an omission should appear to be wholly incompatible with the interest and vocation of the manufacturer. The weight of a carriage—

power requisite to move it from a state of rest—best mode of distributing luggage—best diameter and best proportion of the fore, to the hind wheels, for general use; with other questions of similar import, were, a few years ago, of difficult solution in Long Acre.

If such manifest inattention to scientific rules be found to obtain in cities and towns, among individuals highly educated and amply endowed with the means of instituting experiments on the unerring principles of accredited science; ought it to produce surprize that the art of Road-making, which time immemorial, like the manufacture of butter, has for the most part been confined to the exclusive operative management of individuals, uneducated in the philosophical principles on which the making of sound good roads entirely depend, and uninterested in the result of their labours, should at this day be found in so humble, so subordinate a state.

Whilst a laudable care and protection are sedulously afforded to that noble—that most useful animal the Horse—while many scientific improvements, have, in the course of the last thirty years, been made in the general construction of light carriages, among which is that of placing the whole moving weight on the springs—the greater proportion of which was formerly attached to, and carried as dead weights, on the fore and hind carriage—and while the introduction of several very ingenious and valuable alterations in the construction of wheels, arms and axle-trees, have successfully taken place, by which great relief has been afforded to draught horses;—yet the Roads over which they had to pass; or through which they were destined to drag their load, have hitherto claimed little attention from the scientific world: so little indeed, that the primary nay indispensable considerations of keeping their foundations perfectly sound and dry and their surfaces of proper strength and convexity, have till recently been ungoverned by any determinate scientific rules whatever.

Although various select Committees of the House of Commons have from time to time been appointed to take into consideration the state and condition of the Turnpike Roads, and other Highways; it does not appear from their reports, that any plans for forming roads on scientific principles, or any system for conducting their subsequent repairs had been submitted to their consideration, or that these subjects had so much engaged their time and attention as the best means of preventing the injuries which roads sustained, by the passing of undue weights over their surfaces, on improperly constructed wheels and wheel carriages; these investigations though producing no very substantial benefit to the Roads, have contributed not less to the ease and comfort of travellers, than to the relief of draught horses;—yet no encouragement has been held out by any of these Committees, for the preparation, supply, or scientific application of either natural materials, or artificial substitutes, in making sound substantial roads at bottom, with hard smooth inflexible surfaces. Hence it is, that our old highways are found to partake of artificial undulations and of all degress of convexity, from the segment of a small circle or elipsis, down to the perfect level flat, according to the prepossession of the surveyor in favour of either mode; without having been governed by any system or scientific rules whatever.

An instance some few years since might have been exhibited, where the established rules, adopted in making canals, appeared to have prevailed in the original formation and subsequent repair of a Turnpike-road within 15 miles of the metropolis; here the water at the time referred to, was completely embankéd and confined on each side, by scrapings from off the road, without sufficient openings being left in the banks for the discharge of the water from a Highway destitute of lateral fall. In proportion as roads are kept dry, so if otherwise properly constructed, will they be kept at a proportionably less expense in repair. In proof of this assertion may be adduced the roads in the immediate neighbourhood of London, where to prevent the inconvenience of dust, the frequent use of the water-cart prevails. The statuary cannot saw his marble, nor the lapidary dress his jewels, without the assistance of the powder of the specific material on which he is acting; this when combined with water, produces sufficient attrition to accomplish both purposes. An effect not very dissimilar is produced on gravelled roads. The finer or sandy parts of the gravel when mixed with rain, or water from the carts, materially assist the passing wheels in grinding down the surface, whilst the repairs of such roads as are subjected to this treatment, are found to be infinitely more expensive than those which are not watered. Were gravelled roads so open and porous that the instant the water-cart had performed its office of laying the dust—the water percolated and disappeared, the damage sustained would be greatly reduced, but as the water, in cloudy calm weather, will continue for several hours to lie in the hollow and depressed parts of the surface, in all such places the injury becomes of a very serious description. These roads are principally composed of a clayey gravel, the loamy parts of which so strongly adhere to the pebbles, that the utmost labour in skreening can neither sufficiently detach these nor the coarse sandy gravel; and after continued rain, the surface, by the powder from the pulverization of the fragil stones, the clay, loam, and coarse sandy particles, form not only a canal of slush from side to side, but the surface immediately below this fluid mass, becomes so completely puddled by the traffic through it, before it can be scraped off, as to preclude in a great degree the soakage or admission through it of succeeding showers. When this fluid matter is removed, the height of the road is maintained by a fresh supply of the like materials in precisely the same condition, these are seldom spread more than three inches thick, on a bottom previously made almost water tight, and by the time that they are sufficiently broken down to render a passage over them either easy to the horses or pleasant to those whom they convey; the same operation becomes necessary after the first continued rain for eight and forty hours, of scraping off the mud and replacing fresh materials. This is supposing the road to be covered with well skreened gravel-stones, the finer or sandy parts as much as possible taken out, and the larger pebbles so broken down as that none exceed the average size of a hens egg—but when the stones are surrounded by an indurated clay, or loam enveloped in coarse sand and laid on, of all sizes, without being previously broken, as is frequently seen in the reparation of roads, the evil must increase in proportion to the unfit state of the material applied.

Shingle or beach pebbles when procurable at a practical expense are perhaps one of the best natural materials for making and repairing roads, because the particles of which it is composed are all perfectly clean and free from any grit or extraneous matter, to produce a more speedy pulverisation than what is effected by the usual traffic; and when these are applied to a dry sound bottom kept free from lateral absorption, with a surface preserved in the same state by due convexity, no roads in the island, generally speaking, are found to be in better condition.

Before any further observations on the present state and management of the Public Highways, especially of those in the vicinage of the Capital be discussed, it may not be improper to enquire into the offices, which of necessity, a turnpike or other highway has to perform—to advert to the best *natural* materials for its construction and reparation, in districts where these abound and are procurable at a practical expense,—to suggest the best means of obtaining fit and proper substitutes where such natural materials are not to be had, and to point out the mode of their application so as to insure a sound, permanent, dry foundation, beneath the superincumbent materials of the road; capable of sustaining the moving weights it may be destined to bear in their passage over its surface.

All Turnpike roads and other public Highways ought to be regarded as structures destined to sustain the constant weight of their own materials and those which occasionally pass over them; at the same time facilitating the passage of the latter by presenting a smooth, hard and inflexible surface. In the construction of all edifices which are to support great weights, whether a house, a church, or a bridge; the primary and indispensable consideration of the architect, is, at any expense, to obtain a permanently firm and stable foundation; well knowing, that unless this is first substantially made, no future dependance can be placed on the stability of the intended superstructure. This most requisite precaution has but recently been at all attended to in the formation either of Turnpike or other Roads, and consequently the bed or substratum, on which the Road materials have been laid, being composed of loose substances, trifling impressions are first made, which by the constant repetition of heavy loads passing over them, soon make sensible depressions, and when this effect is once produced, impassable holes are readily formed; heaps of the usual materials are then applied to fill them up to the general level, which in the course of a few winter weeks, will demand further additional supplies of the like substances, to effect the like purpose. A cursory observer would naturally suppose that the surface in such depressed places had been worn down—become mud—had been carried off by attaching itself to the wheels of carriages and feet of cattle, and had left a hole in the road. This supposition however, is incorrect. The hole has not been produced by the superfices being worn down decomposed and carried away; but by the road-materials, having become pressed down, buried and lost in the soft moist substratum beneath them, for want of a proper foundation on which to rest, and resist the passing weight over their surface. As well might the architect expect to prevent further settlement in the wall of a house, or the pier of a bridge, by applying his art to the cracked parapet of the former, or loosened key-stone of the arch of the latter. The evil originates in a total want, or imperfect foundation, and to this fundamental error must his skill be applied to remedy the imperfection in either case. This effect on gravelled and other roads may be further illustrated and proved by the depressed places in the London Streets. When a hollow part is observed, it is commonly ascribed to the wearing down of the upper ends of the stone pavement, but if it be more accurately examined the defect will be discovered to have arisen, not from any reduction in the height of the paving stones, but from a TOTAL WANT OF FOUNDATION to bear up and support the superincumbent weight of the pavement.

As the natural bed, or substratum on which Roads lie, must not only be composed of a great variety of strata, from the hard and inflexible rock, down to the spongy and quaking morass, — in shades also from the tenacious tile earth, to the friable loam and blowing sand—varieties which not unfrequently occur in the short distance of a few poles; it must be assumed as an impossibility to offer more than one or two general rules for making, or keeping in repair any given length of road, with the natural materials, available in the districts through which any specific road may extend. The first consideration, as before observed, in making roads, on scientific principles; like the rearing of every other structure made to support—to prevent settlement, or depression, from superincumbent weight—is the

FOUNDATION. If this be not sufficient and equal to the pressure it is intended to sustain, the whole fabric, though in other respects ever so well contrived, must fail in permanent stability. This primary object cannot be insured, unless the natural bed, or substratum of the Road be kept perfectly free, not only from all lateral absorption, but from any perpendicular admission of water. The former can only be prevented (in old roads) by keeping the surface of the water in the drains, or ditches, running parallel to their line of direction always four inches at least below the bottom of the materials with whichthese roads are made, the latter may be effected in the construction of new, or improvement of old roads by a floor, or foundation capable of supporting the superincumbent weight and rendered impervious to the descending rain. In the formation of new Patent Roads great care is taken that the foundation be kept perfectly free from lateral water, by lines of small under-drains well filled in on each side, and made as deep as will allow of their free discharge into the parallel open water courses.

The *natural* materials for making and repairing roads, may be comprehended under the denominations of Granite, Whin-stone, Lime-stone, Free-Stone, Flint, Seach Beach Pebbles, Gravel, Chalk, with their several varieties; these may possibly be considered, in point of relative value for road-making, to stand as they are here enumerated. The *artificial* substitutes are calcined free, or sand stone, burnt irregular bricks, the refuse matter and scoria from foundaries and other manufactories: iron plates used as railways and tram roads, and VITRIFIED CLAY; for the preparation and application of which to road-making and other useful purposes, His Majesty's Letters Patent have recently issued. The first three of these last mentioned substances are obtainable in small quantities, and in local situations only. The fourth are too expensive for the general purposes of Highways and are exclusively applicable to collieries, mines and manufactories, where great weights are to be removed to comparatively short distances. The fifth will be found to be a valuable substitute for the best natural materials, in districts where fit and proper substances for the construction of roads, are not to be procured, but at an expence that prohibits their application.

In the formation of a new road, whatever may be the particular convexity determined on for the surface, the foundation should partake of the same curvature,by which regulation the whole substance of the road will assume the character of a *bridge* and be proportionably stronger than if formed on a horizontal plane. Much has been said on the convexity of roads. Formerly the barrelled road was the fashion, now an almost perfectly flat one, is as much advocated—the extreme of both, is evidently wrong. Roads partaking in convexity the segment of a small circle, for the sake of lateral drainage, especially in undulating districts, where a perfect level cannot be maintained in any hundred yards, must be wholly unnecessary; the middle part soon becomes the only track,and as much out of repair as if the road was not one third of its width; such roads may be flattened to a rise, at most, of five inches in the centre, where the width shall not exceed 2 poles, or 33 feet; but roads lying on a descent, instead of being less,should often be more round than those on a plane, to insure lateral drainage. In level districts, were longitudinal drainage is difficult to be obtained, it would be equally unwise to disregard a proper curvature, and instead of 5, an elevation of 8 or 9 inches may be found requisite. Even in the former instance a due elevation in the centre will always be found beneficial; because on an inclined plane extending the fourth of a mile or less, if the road be made perfectly flat and without any convexity, the middle will early become concave, and in a heavy continued rain, instead of the water passing off laterally, it will fill the concave middle part, and acquiring force in its descent, will, in rushing down disturb the materials and gull the road. Undoubtedly a proportional rotundity to the width in all cases is necessary, yet it may not be amiss to state, that there are few instances where the rise in the centre would be required to be greater than about half an inch in a foot from that point to each side; this however may be reduced in the application of the materials according to the several local circumstances attending the longitudinal fall in particular parts of the line of road. **Patent Roads, may be made much flatter.**

The immense quantity of gravel, stones and other materials, which from time to time have been buried in filling up the surface holes, and in making level the depressed places in most of the old Turnpike roads; have at length provided them with a sort of *imperfect foundation*. This must necessarily be unequal in various parts of it, to the weight and partial pressure it has constantly to sustain of its own superincumbent materials; the gravitating force of which, in continued wet weather, often becomes very perceptible at the surface, though the effect of heavily laden carts and waggons should not have contributed to its depression.

A cubical foot of selected gravel-stones, principally weighing from an ounce, and ounce and half, to four ounces, the size of a hen's egg, and none exceeding six ounces, will weigh from 108 to 112lbs.—consequently a cubical yard, will weigh from 26 to 27 cwt.—but as the stones with which the old roads were originally formed and with which they have since been uniformly repaired, were infinitely larger and more ponderous, it may fairly be presumed, that every square yard of their adventitious foundations has to support a continued pressure of at least one ton and an half. When to this *constant* gravitating force is superadded the occasional and frequent compression of moving weights of 4, 5, & 6 tons, it is demonstrably certain, that every foundation so accidentally and unscientifically produced, must occasionally yield in some of its parts—is wholly unfit and incapable, especially in rainy seasons, of preventing the lower materials from being pressed down—sunk and lost beneath it, or the upper surface from being depressed and worn into holes.—Yet if these infirm foundations be laid perfectly dry and effectually protected from the approach and admission of water as before recommended—and that they are always strictly attended to, they may be made tolerably strong for the constant support of their own weighty materials, though not with either the certainty or security which the Patent process insures, of sustaining any occasional additional weight, without depression.

Various as may be the substratum and its component parts; the excellence and perfection of public Highways are alike in all cases—supporting the mass of their own superincumbent materials and the moving weights passing over their superfices, by a substantial impervious floor, or foundation—and facilitating the labour of horses,—the motion of carriages,—the expedition and comfort of travellers, by a compact, hard and smooth surface, allowing of as little impression and as few ruts being made in it, as possible.

These are the principal desiderata in the construction of permanently sound Turnpike and other Highways, and that practical system of road-making which can effect both at the least expense; requires nothing but common sense for its advocate and adoption.

The natural materials of which the foundation (the primary object) and afterwards the substance, or body of a road up to its surface are to be composed, come next under consideration.

Should the foundation be constructed agreeably to the Patent process, though of natural materials, whether consisting of granite, whin-stone, lime-stone, free-stone, flint, land or gravel-stones, these may be all used of considerable size in its formation—of any shape or figure, those only being preferred that have one flat side for imbedding on the substratum. The irregularity of the other sides is unimportant, because, when disposed of in the shape of a pavement, all the irregularities of the upper side, are filled up with small pieces of the stone, or small pebbles, until it become a tolerably even floor when by small skreenings from the like materials it is made completely level from 4 to 6 inches deep as the case may require; the whole is then grouted and united together by the aid of hot lime and water; which when properly executed, soon renders it impervious to water. When this grouted FOUNDATION is paved on a convex substratum of clay or other compact body, it excludes the admission of rain from the clouds, and if the lateral absorption of water from the side ditches be prevented by parallel under-drains, it is next to an impossibility that the natural bed should ever give way, or become so soft as to produce any depression of the arch made floor, or foundation, bound as its parts are effectually together, by the process of paving and grouting. The foundation being thus substantially made and rendered impenetrable, the materials for the upper part, if stone, should all be broken into the size of a cubical inch or there-abouts—if of pebbles, none should exceed the common size of an hen's egg, or weigh more than from four to six ounces; those of a larger description should all be broken. Two objects of advantage are attained by breaking down the large pebble-stones—it provides the globular mass of pebbles with angular pieces, which greatly assist their binding together, and it also furnishes small fragments for the exterior parts, which, with the chippings of the stones, or the small pebbles not exceeding two ounces in weight, should be carefully separated and reserved for the 2 or 3 inches of external covering, including the ballast on the upper part, or crown of the road. As few stones are of the same specific gravity, and as limestone is found to vary from 1386 to 2390, in districts where a choice of natural materials is presented, all other circumstances being equal, or nearly so; stones of the least specific gravity ought to be preferred. A prodigious expense in cartage may thus be saved, whilst the natural bed or substratum on which the road rests will have less *constant* weight to support.

Although it is not generally so understood, yet the fact is capable of proof; that the principal injuries sustained by excessive weights passing over Turnpikes and other Roads, are all first received at the *bottom*, or what in old Roads is improperly called the *foundation;* but, as these mischiefs do not become perceptible, till indicated by inequalities in the surface, the evil is naturally referred to the *top*; to which the ability of the surveyor is, from necessity, constantly directed for temporary relief and amendment. It is, however, the bottom, and not the top of roads of every description, that demands the exercise of his professional ability, care, and attention; for if the Public Highways were composed of, and covered with adamantine materials, and these broken as small as the eggs of hens, it must be obvious that unless the mass rest on an unyeilding solid foundation, the undermost heavy parts from their gravitating power, assisted by the occasional pressure of great moving weights, will naturally sink into, and be as it were, absorbed by the soft natural substratum. A bottom of clay, loam &c. when sufficiently softened by water into a paste is by such constant gravitation and occasional pressure, perpetually squeezed up between each pebble or portion of stone; this makes room for the descent of others, every particle of which becoming a conductor of water from the surface, necessarily keeps the bottom always wet, soft, and in a fit pulpy state to swallow up and give place to the weighty materials daily supplied on the top in repairing the surface.

Having explained the offices, or services which the public has a right to expect from well conducted Turnpike Roads and other Highways and having suggested a method by which the principal defect in the formation of the old roads, may, to a certain extent, be remedied, as also the means, of obtaining a most substantial and permanent improvement by the adoption of so much of the improved new Patent process as relates to the forming an impenetrable and immoveable foundation on the substratum with natural materials, together with the most approved mode of their further application, in districts where they abound, or are practically procurable—the new Patent process for manufacturing and providing hard and durable materials, in districts, where neither stone, gravel, nor chalk are obtainable—but at a price that forbids their use in the Highways, comes next under dicussion.

Neither pure clay nor pure sand is vitrifiable by fire separately and by itself, but any mixture of the primitive earths, the other three being the calcareous, ponderous and magnesian, especially if the calcareous be one in the mixture, fuses and vitrifies the mass very readily. In all the common clays approximating the surface, one half of their solid contents is, on analysis, found to be sand; of course such clays are vitrifiable; but in alluvial valleys or where the calcareous earth forms a component part, as in the case of *all* marles, the operation is greatly facilitated. Clay, when subjected so long to the fire as to destroy its orginal texture and the whole of the carbonaceous matter it may contain, which is discoverable when broken, by its not being internally black, becomes a very hard substance—will imbibe no water—and is not acted on by the severest frosts in South Britain; but when it is more perfectly fused, or vitrified and will strike fire with steel, it becomes of less than half the specific gravity of pebbles gathered from the land, or found in gravel pits; is more than double the cubical contents of such stones, though of equal weights, and will sustain as great weight, without being crushed, as the common gravel-stones of equal dimensions. When gravel is ground down on the roads, a process greatly assisted by the finer or sandy parts of it adhering to the pebbles, a paste is formed; hence the abundance of mud and slush, that is accumulated in wet weather and which is obliged to be scraped off; but there is no possibility of making a paste with pounded vitrified, or fused clay, consequently all roads made with this material, which greatly resembles the scoria from iron furnaces and lava, will not be liable to so great an inconvenience, nor, can they ever be so wet, or splashy in rainy seasons; because the whole body or substance of the road above the FOUNDATION being made with the same non-absorbent materials; and lying very hollow, acts as a constant under-drain, through which the surface water very readily percolates and descends until, it meets the impervious flooring, which guards the under-drains on each side, made parallel to the direction of the Road, for preventing lateral absorption and is discharged into the open water courses.

On constructing a new Road on the Patent principle over a substratum of clay, the space it is intended to occupy is to be excavated one foot deep, or more, according to circumstances; the excavated clay, after it is dried, is to be wheeled (by hand) to a central fire and vitrified; the mass is then to be broken up and the natural bed being prepared and formed with the same convexity which the surface is to assume, A FOUNDATION or flooring is made with the larger fragments, preferring those with one flat side for imbedding on the natural clay. The irregularities and interstices of the upper sides as also the spaces, or vacancies between the several pieces, are then filled up with the chippings, or little pieces and the skreenings are spread over the whole; after whichit is slightly beaten to shake the small particles down into the intervals and the whole is finished by being grouted together with hot lime and water. If the natural bed be a solid clay this FOUNDATION, or flooring extending from drain to drain, in all roads not exceeding 2 poles or 33 feet in width, need not exceed 4 or 5 inches in thickness; if a more tender substratum it might be necessary to increase it an inch, or something more; and in both cases regard must be had to the moving weights to which the superfices of the road may be subjected. In this construction of a Highway as all lateral absorption of water is provided against by under-drains and as that which falls perpendicularly descends through the body of the road only to the upper surface of the FOUNDATION; the natural bed or substratum must always be preserved dry and capable of sustaining equally in all its parts the bond of masonry laid upon it, which will continue a permanent and substantial protection against all future depressions. In roads exceeding two poles in width, before the FOUNDATION is laid, transverse under-drains should be made in the substratum similar to and communicating with the parallel ones, at the distance of every pole, it being practically well understood that in adhesive strong land, perfect drainage cannot be effected by drains at a greater distance than one pole a part.

The Coach-way pavement in the streets of London, entirely resting on loose, made ground, and not on any solid or substantial foundation, is not only very expensive to keep in repair, but produces material injury to the front walls of the houses on each side, by the vibrating, tremulous motion which is communicated to them on the passing of every heavily laden waggon, or cart over its surface; and were it not that the pavement is liable to be occasionally disturbed, no doubt can be entertained that a Patent grouted flooring, or FOUNDATION would be the best and most economical expedient that could be resorted to, for preserving the pavement from depression, and the front walls of the houses from injury.

The immediate surface or exterior covering made with the smaller parts, neither the powder nor particles of which are absorbent of water, and consequently never affected by frosts; will in few cases require to be more than 2 or 3 inches thick. This must necessarily suffer diminution of its parts from attrition and be shaken down into vacancies in the stratum below, but when replenished,—assisted by ballast, or small gravel, and rolled down with a heavy roller, the particles, from their great irregularity of shape, will hold each other so tightly and firmly together, that they will not be easily disturbed;—will soon become hard,—solid,—compact;—and instead of a newly made, or repaired Patent Road, being unpleasant to travel over, as is the case on those that are gravelled; Roads thus made will immediately be perfectly firm and smooth.

The Patent Road is divided into three distinct Strata. The Foundation, Middle stratum, and exterior covering, or Surface. Large pieces from 4 to 6 inches square are used in the FOUNDATION, those not exceeding 3 inches fill up the Middle stratum and such as will pass through a skreen or riddle, of meshes 2 inches square, are applied to the Surface. Meshes of these dimensions will admit gravel-stones or other pebbles through them, weighing 4, 5, and 6 ounces, whilst the portion of vitrified or fused matter that would as readily pass, will rarely be found to weigh more than 20 drams, or one ounce and a quarter. This difference in point of specific gravity, may possibly induce an apprehension that the Patent materials would fail in sustaining the legal weights, which may be required to pass over the surface of roads so constructed. The extreme irregularity of shape in the vitrified and fused fragments of which the Surface, Middle stratum and FOUNDATION of Patent roads are composed, form such a system of resistance to the superincumbent weight as to give to every part of their solid contents the quality and strength of an arch; and while this has the effect of affording great support, it widely distributes both the constant and occasional weight, resting on the surface, and subtends and disseminates the pressure on one square foot probably over some square yards ere it reaches the natural substratum. These irregularities of shape from their hardness and being pefectly dry constitute a principal feature of encouragement as to the successful construction of Patent roads by their readily admitting all the spaces and interstices necessarily formed between each piece as well as in the pieces themselves, to be so perfectly filled up, as to give the whole percolating body of the road, as well as the foundation, the character of one completely solidified arch formed mass; capable in the general opinion of bearing up without depression any weight allowed by law to pass over its surface.

In the common mode of road-making 10 inches of well consolidated materials are considered as equal to carry any thing on roads formed without a foundation; and lying on a natural soft bed constantly supplied with water, this fact furnishes reason to presume that a Road constructed on scientific principles with the Patent light materials 12 inches in depth resting on an imperishable, consolidated FOUNDATION, and a perfectly dry substratum, would be found equal in point of resisting strength,—and if so, certainly of greater durability, than roads made with heavy natural materials, having an increased tendency to gravitate, sink, and be lost in a soft bed of wet, yeilding clay.

It has before been observed, and it may not be improper to repeat, that roads of this description destitute of a solid foundation to sustain the constantly gravitating force of their own materials, which is in exact proportion to their cubes, acting perpendicularly, powerfully and partially to the amount of at least one ton and an half on every square yard, besides the occasional weights of the traffic passing over their surfaces, must unavoidably be liable to constant depressions, and be extremely expensive to keep in repair. All smooth stones and pebbles of a globular or circular form, act as immediate conductors in supplying the natural bed, on which they lie, with water, by which means their tendency to sink into it, is much facilitated, and by the repeated action of occasional pressures on the top, the natural bottom is perpetually squeezed up superficially among them, making room for fresh particles to subside and settle down as they are supplied on the top, for maintaining a level surface. None of these evils and objections attend the Patent system; in the progress of which, the natural substratum can receive neither perpendicular nor lateral water; the former in its descent is stopped by the impervious floor—falls to the right and left, and is discharged into the open water courses, while the under-drains prevent all lateral absorption, by running parallel and close under the edge of the arch formed FOUNDATION. This is capable of great resistance, though it would not constantly have to sustain a greatly distributed gravitating force of more than 10cwt. of road materials on each square yard, and consequently, one ton less on all occasional pressures, than in the former instance, of a road composed of natural materials; where from their shape, if small and globular, the surface pressure is not likely to be much otherwise than directly perpendicular; whilst the weight, whether constant or occasional, sustained by a Patent Road, would from the divers forms of its infinitely angular materials and its compaction, derive prodigious power of resisting pressure, a quality, which would be so diffused over and through the whole mass, as that the weight of a loaded waggon moving longitudinally on the width of four feet and an half, would most likely be so spread, as to be ultimately sustained by as many square yards. Such an effect cannot be produced but in roads formed with somewhat large materials, lying hollow, and from their diversity of shape, producing a series of innumerable arches. This circumstance bids fair to encourage a hope, that should the Patent material in a separate form, be found more liable to be crushed than the harder natural materials, yet in a state of combination, it will be found equally fit and adapted to sustain the legal superincumbent weights; and thus compensate for any actual deficiency in point of comparative hardness. Supposing 30 cwt. of perpendicular pressure be required to crush a *single* pebble stone, or an *individual* piece of vitrified matter of the same cubical dimensions; when such materials are respectively in mass, or in bulk, as in the body of a road, resting on others of a similar form and description, each substance will be found to sustain the crushing weight, with the least injury, in the exact proportion of the points of bearing, with which each is furnished. Now as pebble stones are of a circular form, their points of bearing are few, when compared to those attending the various irregular unequal angular forms, which vitrified matter assumes when broken into fit portions for the application of it to the respective strata of Roads, and consequently the latter will be found to support the weight with infinitely less destruction of its contiguity of parts than the former.

The value of the Patent process is further advanced by its materials being obtainable in districts, where neither stone, gravel, nor chalk, for making roads are to be procured on admissible terms. In the stiff clays of the County of Sussex where there is no gravel, and where stone can only be had at a prodigious expense, the adoption of the Patent system will be found highly advantageous. The same beneficial consequences will result to all those districts of other counties, such as the lower parts of Norfolk, Woodland parts of Suffolk and Essex, Bedfordshire, the Isle of Ely, parts of Lincolnshire, &c. &c. where hard road materials are not available; indeed there is great reason to believe that in many places not entirely destitute of natural and fit substances for the like purpose, but lying remotely from the line of road to be made, or repaired; the adoption of the Patent process would be found to be the most economical as well as best mode of proceeding.

However great the prospective advantages may appear in pecuniary and other points of view, to individuals, having it in contemplation to construct a new road on the Patent principles; yet the beneficial effects of adopting the process in a popular point of light, will supersede these considerations, by diffusing widely through the district in which any proposed line of such road may be extended, full employment to the labouring classes. The formation of a Patent road, unlike that of other Highways, depending, not on the daily long trains of loaded carts for supplying materials, but relying simply and exclusively on its own natural substratum, rendered fit for the purpose on the spot, by the labour of men, women and children, in excavating, wheeling, drying, vitrifying, and returning it again, when duly prepared and separated, to the place whence it had been taken; must necessarily afford employ to numbers at their own doors, and saving and excepting the value of fuel and lime, for vitrifying and grouting and the expense of carting these requisites, the whole cost of constructing a Patent road, is exclusively incurred by MANUAL LABOUR.

In the process of obtaining vitrified materials from the natural substratum, different degress of heat in the clamp or fire, which are unavoidable, will produce different substances of four descriptions, all of which, however, are found, in the several applications of them, useful and important in the formation of a Patent road. These four substances may be distinguished under the general heads of Burnt Clay, Calcined Clay, Fused Clay, and Vitrified Clay.

First. Burnt Clay, or Clay so changed by the action of fire, that it will neither absorb water, nor fall into a powder by the severest frosts in South Britain; when beaten into small pieces by women and children, is applicable to the under-drains, and highly useful in filling up the several spaces and interstices of the FOUNDATION, as well as assisting in the consolidation of the whole body of the road.

Secondly. Calcined Clay is sufficiently hard and strong to assist the fused materials in forming the Middle stratum of the road.

Thirdly. Fused Clay. The principal part of this material is applied to the formation of the Middle stratum, the harder, or more completely fused parts approaching to vitreous matter, assist in forming the foundation. This is highly important as it allows portions of No. 4. to be broken sufficiently small for the external or surface covering.

Fourthly. Vitrified Clay. The larger portions of this matter with the more completely fused parts of No. 3. form the convex grouted floor, or FOUNDATION on which rests the whole constant weight of the superadded materials as well as the occasional weight of the traffic; and requires to be substantially executed.

In breaking up the mass the small portions from Nos. 3 and 4 are selected and reserved for the covering of the upper surface, while the like description from Nos. 1 and 2 help to fill up the interstices and to consolidate the whole substance of the Road.

It may not be amiss as a concluding remark by which a comparative estimate may be formed of the expenses incident to the old process and those incurred by the new Patent system, to state, that although skreened gravel for roads is a costly article, yet it is the carriage of it, that renders the present mode of road-making and keeping them in repair, so very expensive. In the prosecution of the Patent system, carting of materials is scarcely known, nor does it need the expense of Horse labour, but for the conveyance of Fuel and Lime. Excepting in these two particulars the whole business is begun and perfected on the spot by the labour of men, women and children; who, if properly appointed and regulated, would be capable of making a mile of Road in the course of a summer month, instead, as is frequently the case, a year being expended on its construction.

Such actual experiments as have been instituted, and which from the recent grant of the Patent and humidity of the season in which they were commenced, have necessarily been few, and those on a limited scale, afford well grounded reason to believe, that by the general adoption of the Patent System and its Scientific principles, in the future management of the 25000 miles of Turnpike Roads, stated to pass through England and Wales and annually to cost in their repairs *a million and a quarter*, a very material reduction would not only take place in this yearly expenditure, but that in the course of a few years, the SEVEN MILLIONS of debt, with which the several Trusts are said to be encumbered would be nearly, if not entirely extinguished.

As the Letters Patent not only extend to the preparing or manufacturing substances for the formation of the Highways and other Roads—but to "other useful purposes," the application of the Patent Materials to Hollow, or UNDER-DRAINING of Land, will be found a most important and highly beneficial practice, by providing against the two powerful objections which are constantly operating to prevent a more general adoption of this most useful of all rural improvements. The heavy charges incident to this operation and the frequent occasional failures in the Under-drains, after such charges have been incurred. These have had the effect to prevent thousands of acres from being thus laid dry and converted into good sound meadow and pasture land. Both discouragements owe their origin to one and the same cause; the prodigious expense and damage attending the carting of stones, or other materials with which under-drains are to be filled in, to the places destined for their rats and other vermin, as the angular parts of the materials are too many, too hard, and too sharp, for them to burrow, and consequently to breed in. Another economical purpose to which also it may be applied, where the cost of bricks and the cartage of them even from a little distance, form the most expensive part of the building of cottages; the patent vitrified materials capable of being produced on the spot, without horse or cattle labour, will be found to be a most valuable acquisition.

THE END.

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